DESCRIPTION

UNDERGROUND STRUCTURE COVER

TECHNICAL FIELD

This invention relates to an underground structure cover comprising a cover body and a receiving frame, particularly a support structure in which the cover body is supported by the receiving frame.

It is to be noted that the term "underground structure cover" is used in this specification as a generic term referring to a class including manhole covers, large iron covers and sewage pit covers for covering an opening leading from the ground surface to an underground installation, underground facilities or the like of a sewer system; openable multipurpose-duct iron covers, power-transmission covers and power-distribution covers for protecting underground power or communication facilities, apparatus, cables or the like; and hydrant covers, gate valve covers, sluice valve covers, air valve covers, gas pipe covers and water meter covers functioning as a door allowing access from on the ground to a water-supply pipe, sewage pipe or gas pipe buried under the road and additional equipment for such pipe.

BACKGROUND ART

Conventionally, as an underground structure cover, one having an inclined receiving structure is common in which the cover body is fitted in and supported by the receiving frame so that an inclined surface formed at the outer circumference of the cover body is wedged inside an inclined surface formed at the inner circumference of the receiving frame. As an underground structure cover having

this inclined receiving structure, Japanese Unexamined Patent Publication No. sho 53-72357 discloses one in which the angle of inclination of the inclined surface with respect to the vertical plane, that is the vertical angle, is limited to 5° to 10°. In the underground structure cover disclosed in Japanese Unexamined Patent Publication No. sho 53-72357, by limiting the vertical angle like this, it is ensured that the cover body is wedged into the receiving frame by a sufficient force by a sufficient depth. By this, the cover body's wobbling, shaking or rattling can be suppressed to a great degree, and the cover body is almost prevented from riding up (becoming inclined instead of staying horizontal).

While the underground structure cover disclosed in Japanese Unexamined Patent Publication No. sho 53-72357 has the above-mentioned beneficial effects, the cover body thereof can be wedged into the receiving frame too deeply, in some setting environment. Thus, sometimes a large amount of labor is required to open the cover with a bar, and sometimes there is difficulty in opening the cover.

Further, in the case such that a load is applied to the cover body in a manner concentrated on a peripheral part thereof, the cover body may be fitted in and supported improperly, which may cause the cover body to become inclined or ride up.

In order to prevent the cover body from being wedged into the receiving frame too deeply, Japanese Examined Utility Model Publication No. sho 60-19162 discloses an underground structure cover in which the inclined surface of the cover body includes an intermediate gently-inclined part and the inclined surface of the receiving frame includes an intermediate gently-inclined part, so that, when the cover body is fitted in the receiving frame with

their inclined surfaces meeting each other, a gap is left between the gently-inclined part of the cover body and the gently-inclined part of the receiving frame.

However, in the underground structure cover disclosed in Japanese Examined Utility Model Publication No. sho 60-19162, the gap can only delay the cover body getting wedged deeper (sinking) into the receiving frame, and cannot provide a fundamental solution for preventing the cover body from being wedged in too deeply. Further, no consideration is given to the problem that the cover body becomes inclined or rides up.

DISCLOSURE OF THE INVENTION

An object of the invention is to provide an underground structure cover that can prevent the cover body from being wedged into the receiving frame too deeply and also from becoming inclined with respect to the receiving frame or riding up.

In order to achieve the above object, the underground structure cover according to the present invention comprises a cover body and a receiving frame designed so that the cover body is fitted in and supported by the receiving frame in the manner that an inclined surface formed at an outer circumference of the cover body is received on an inclined surface formed at an inner circumference of the receiving frame, wherein the inclined surface of the outer circumference of the cover body and the inclined surface of the inner circumference of the receiving frame each include an upper inclined surface and a lower inclined surface, the lower inclined surface is steeper than the upper inclined surface in each of the cover body and the receiving frame, and the cover body is fitted in and supported by the receiving frame so that the

upper inclined surface and lower inclined surface of the cover body are received on the upper inclined surface and lower inclined surface of the receiving frame, respectively.

In the underground structure cover of the inclined receiving structure, when the inclined surfaces of the cover body and the receiving frame are steeper, the force which wedges the cover body into the receiving frame is greater, so that the cover body's becoming inclined with respect to the receiving frame or riding up can be suppressed. Meanwhile, when the inclined surfaces of the cover body and the receiving frame are gentler, the force which wedges the cover body into the receiving frame is smaller, so that the cover body can be prevented from being wedged in too deeply. In the present invention, it is so arranged that the cover body is fitted in and supported by the receiving frame at its upper inclined surface and lower inclined surface which are different in inclination. By this, the force which wedges the cover body into the receiving frame can be controlled as a whole, so that the cover body can be prevented from being wedged into the receiving frame too deeply.

When the inclined surface is gentler, the horizontal component of the force is greater. This means that the force deforming the receiving frame radially outward is greater, and hence the deformation of the receiving frame is greater. Further, as a basic structure for the receiving frame, the structure in which an inclined surface is formed at the upper part of a cylindrical part, and a flange is formed at the bottom of the cylindrical part is common. In this structure, the rigidity of the cylindrical part of the receiving frame becomes higher downward, so that the deformation thereof caused by external force becomes smaller downward. In the present invention, it is

arranged that the lower inclined surface is steeper than the upper inclined surface. By this, it is ensured that the cover body is wedged into the receiving frame mostly in the region of the lower inclined surface of the receiving frame which has higher rigidity and hence is less deformed by external force. Consequently, the cover body is fitted in and supported by the receiving frame properly, so that the cover body's wobbling or riding up can be suppressed.

Further, in the present invention, since the cover body is fitted in and supported by the receiving frame at two places, namely at its upper inclined surface and its lower inclined surface, the cover body can be securely fixed to the receiving frame and its shaking and wobbling can be prevented.

In the underground structure cover according to the present invention, it is desirable that, when the cover body is fitted in and supported by the receiving frame, a gap be left between the cover body and the receiving frame so that the outer circumference of the cover body and the inner circumference of the receiving frame do not touch each other in a region between their upper inclined surfaces and their lower inclined surfaces. By leaving the gap between the cover body and the receiving frame like this, the area of contact between the inclined surface of the cover body and the inclined surface of the receiving frame can be adjusted. By this, the force which wedges the cover body in can be easily controlled.

Further, the underground structure cover according to the present invention can be so arranged that the cover body is round in shape and that the gap is defined by an intermediate inclined surface between the upper and lower inclined surfaces of the cover body and an intermediate inclined surface between the lower and upper inclined

surfaces of the receiving frame. In this case, the intermediate inclined surface of the receiving frame is formed as a continuously curved surface which connects the upper and lower inclined surfaces of the receiving frame and includes a receiving-frame convex part projecting to the inside of the receiving frame and a receiving-frame concave part located above the receiving-frame convex part, while the intermediate inclined surface of the cover body is formed as a continuously curved surface which connects the upper and lower inclined surfaces of the cover body and includes a cover-body concave part corresponding to the receiving-frame convex part and a cover-body convex part corresponding to the receiving-frame concave part.

In the case where the intermediate inclined surfaces are provided like this, when the cover body is pushed from behind into the receiving frame in order to close the cover, the lower part of the cover-body convex part comes in contact with the upper part of the receiving-frame convex part. Then, when the cover body is further pushed from behind, the contact area of the cover-body convex part at which the cover-body convex part is in contact with the receiving-frame convex part gradually shifts forward in the manner that the cover-body convex part is guided by the receiving-frame convex part. Thus, the cover body can be smoothly fitted into the receiving frame only by pushing in the cover body from behind.

In the present invention, it is desirable that the vertical angle of the lower inclined surfaces of the cover body and the receiving frame be in the range of 3° to 10°, and the vertical angle of the upper inclined surfaces thereof be in the range of 7° to 20°. With this desirable arrangement, the force which wedges the cover body into the receiving frame can be controlled precisely to achieve both

the prevention of the cover body being wedged in too deeply and the suppression of the cover body becoming inclined with respect to the receiving frame or riding up, to a high degree.

BRIEF DESCRIPTION OF THE DRAWINGS

[FIG. 1] An exploded perspective view of an underground structure cover in an embodiment of this invention.

[FIG. 2] A partial vertical cross-sectional view showing relevant parts of the underground structure cover in a state that a cover body is lifted off a receiving frame.

[FIG. 3] A partial vertical cross-sectional view showing the relevant parts of the underground structure cover in a state that the cover body is fitted in and supported by the receiving frame.

[FIG. 4A] A cross-sectional view showing the underground structure cover shown in FIG. 1 in a state that the cover body is almost laid on the receiving frame, for explaining how the underground structure cover is closed.

[FIG. 4B] A partial cross-sectional view along line IVB-IVB in FIG. 4A.

BEST MODE OF CARRYING OUT THE INVENTION

As shown in FIG. 1, an underground structure cover comprises a round cover body 10 and a receiving frame 20 for receiving and supporting the cover body 10. The cover body 10 is connected with the receiving frame 20 by a hinge (not shown) and can open and closes the receiving frame 20.

The cover body 10 has an inclined surface 11 formed at its outer circumference, while the receiving frame 20 has an inclined surface 21 formed at the upper part of the

inner circumference of its cylindrical part 22 to fit with the inclined surface 11 to support the cover body 10. The receiving frame 11 has a flange 23 at the bottom of the cylindrical part 22. This underground structure cover is fitted, for example, to the upper end of an upper block of a manhole so that the upper surface of the underground structure cover is flush with the ground surface.

FIG. 2 shows the underground structure cover in a state that the cover body is lifted off the receiving frame. As shown in FIG. 2, the inclined surface 21 of the receiving frame 21 comprises an upper inclined surface 21a which tapers downward to decrease the inner diameter of the frame 21, a lower inclined surface 21b which also tapers downward to decrease the inner diameter of the frame 21, and a continuously-curved intermediate inclined surface 21c which connects the upper inclined surface 21a and the lower inclined surface 21b.

The intermediate fitting part 21c includes a receiving-frame convex part 21c-1 which projects toward the inside of the receiving frame 20, and a receiving-frame concave part 21c-2 which follows the receiving-frame convex part 21c-1 on the upper side. The receiving-frame concave part 21c-2 is followed by the upper inclined surface 21a on the upper side, and the receiving-frame convex part 21c-1 is followed by the lower inclined surface 21b on the lower side.

Thus, the inclined surface 21 of the receiving frame body 20 forms an S-shaped curved circumferential surface as a whole, and thereby forms the inner circumferential surface of the receiving frame 20 having a shape like an inverted truncated cone.

Meanwhile, the inclined surface 11 of the cover body 10 comprises an upper inclined surface 11a which tapers

downward to decrease the outer diameter of the cover body, a lower inclined surface 11b which also tapers downward to decrease the outer diameter of the cover body, and a continuously-curved intermediate inclined surface 11c which connects the upper inclined surface 11a and the lower inclined surface 11b.

The intermediate inclined surface 11c includes a cover-body concave part 11c-1 which corresponds to the receiving-frame convex part 21c-1, and a cover-body convex part 11c-2 which follows the cover-body concave part 11c-1 on the upper side and corresponds to the receiving-frame concave part 21c-2. The cover-body convex part 11c-2 is followed by the upper inclined surface 11a on the upper side, and the cover-body concave part 11c-1 is followed by the lower inclined surface 11b on the lower side.

Thus, the inclined surface 11 of the cover body 10 forms an S-shaped curved circumferential surface as a whole, and thereby forms the outer circumferential surface of the cover body 10 having a shape like an inverted truncated cone.

In order that the cover body 10 can be fitted in the receiving frame 20, the angles of inclination of the upper inclined surface 11a and of the lower inclined surface 11b of the cover body 10 are equal to those of the upper inclined surface 21a and of the lower inclined surface 21b of the receiving frame 20, respectively, and the outer circumferential surface of the cover body 10 and the inner circumferential surface of the receiving frame 20 have shapes complementary to each other.

It is to be noted that the lower inclined surfaces 11b and 21b are steeper than the upper inclined surfaces 11a and 21a. For example, the vertical angle of the lower inclined surfaces 11b and 21b is set in the range of 3° to

10°, for example, at 6°, while the vertical angle of the upper inclined surfaces 11a and 21a is set in the range of 7° to 20°, for example, at 10°. By arranging that the lower inclined surfaces of the cover body 10 and the receiving frame 20 are 4° (generally, 1° to 10°) steeper than their respective upper inclined surfaces like this, the force which wedges the cover body 10 into the receiving frame 20 can be controlled precisely. Thus, as described later, the prevention of the cover body 10 being wedged into the receiving frame too deeply, and the suppression of the cover body 10 becoming inclined with respect to the receiving frame 20 or riding up can be both achieved to a high degree.

FIG. 3 shows the underground structure cover in a closed state where the cover body is fitted in and supported by the receiving frame. As shown in FIG. 3, in the closed state, the upper inclined surface 11a and lower inclined surface 11b of the cover body 10 meet the upper inclined surface 21a and lower inclined surface 21b of the receiving frame 20, respectively, so that the cover body is fitted in and supported by the receiving frame at two places, namely at the upper inclined surface 11a which meets the upper inclined surface 21a and at the lower inclined surface 11b which meets the lower inclined surface 21b. Meanwhile, the intermediate inclined surface 11c of the cover body 11 does not meet the intermediate inclined surface 21c of the receiving frame 21c, so that a gap is formed between them. The gap can be made, for example, by making the upper inclined surface 21a of the receiving frame 20 longer than the upper inclined surface 11a of the cover body 11.

Table 1 shows the result of analysis of the displacement of the cover body caused by applying a load to

a peripheral part of the cover body fitted in and supported by the receiving frame, under the conditions below, where the vertical angles of the inclined surfaces were changed.

Diameter of cover body: 650mm

Total height of inclined surface: 39.5mm

Height of upper inclined surface: 5mm

Height of lower inclined surface: 5mm

Coefficient of friction between inclined surfaces: 0.16

Area of the part at which load is applied (size of load bearing plate): 200×200mm

Rate of applying load: 10kN/sec

[Table 1]

	Vertical angle		Behavior of cover body (displacement) (mm)					
			When load is applied			After load is removed		
	Upper inclined surface	Lower inclined surface	A	B	|A-B|	A	B	|A-B|
Example	12°	6°	0.151	-0.407	0.558	0.238	-0.051	0.187
Comparative example 1	6°	6°	0.171	-0.566	0.737	0.192	-0.186	0.378
Comparative Example	6°	12°	0.659	-0.897	1.556	0.951	-0.652	1.603

A: Side on which load is applied,

B: Side on which no load is applied

As shown in Table 1, in the example of the present invention in which the lower inclined surface was steeper than the upper inclined surface, the displacement of the cover body was smaller compared with comparative example 1 in which the lower inclined surface was equal in the vertical angle to the upper inclined surface and comparative example 2 in which the lower inclined surface

was gentler than the upper inclined surface. Thus, it was confirmed that in the present invention, even if a load is applied to the cover body in a manner concentrated on a peripheral part thereof, the cover body's being wedged in too deeply can be prevented, and also the cover body's becoming inclined or riding up can be suppressed.

Next, with reference to FIG. 4, how the underground structure cover according to the present invention is closed will be explained. FIG. 4A shows a cross-sectional view of the underground structure cover in a state that, in order to close the underground structure cover that was once opened, the cover body has been turned horizontally, so that the cover body is almost laid on the receiving frame. FIG. 4B shows a cross-sectional view along line IVB-IVB in FIG. 4A at a contact area between the inclined surface of the cover body and the inclined surface of the receiving frame in this state.

As shown in FIG. 4B, when the cover body 10 is almost laid on the receiving frame 20 in order to close the underground structure cover, the lower part of the cover-body convex part 11c-2 comes in contact with the upper part of the receiving-frame convex part 21c-1, which prevents the cover body 10 from coming down into the receiving frame too deeply. In this state, when the cover body 10 is pushed in obliquely downward by pushing it at the rear part (left end in FIG. 4A) with a foot, the part of the cover-body convex part 11c-2 at which the cover-body convex part 11c-2 is in contact with the receiving-frame convex part 21c-1 gradually shifts forward (to the right in FIG 4A) in the manner that the cover-body convex part 11c-2 is guided by the receiving-frame convex part 21c-1. With this, the front part (right end in FIG. 4A) of the cover body 10 gradually rises, and eventually the cover body 10

completely fits into the receiving frame 20. Like this, the underground structure cover according to the present invention is so arranged that, when it is going to be closed, the cover body 10 shifts in the manner that the cover-body convex part 11c-2 is guided by the receiving-frame convex part 21c-1. Hence, only by pushing the cover body 10 in, the cover body 10 can be smoothly fitted into the receiving frame 20.

The beneficial effects which the underground structure cover in the above embodiment has are as follows:

1. The cover body is fitted in and supported by the receiving frame at its upper inclined surface and lower inclined surface which are different in the vertical angle. By this arrangement, the force which wedges the cover body into the receiving frame can be controlled as a whole, and the cover body can be prevented from being wedged in too deeply.

2. Since the lower inclined surfaces are steeper than the upper inclined surface, the cover body is wedged into the receiving frame mostly in the region of the lower inclined surface of the receiving frame which has higher rigidity and hence is less deformed by external force. Thus, the cover body can be prevented from becoming inclined with respect to the receiving frame or riding up.

3. Since the cover body is fitted in and supported by the receiving frame at two places, namely at its upper inclined surface and lower inclined surface, the cover body can be fixed to the receiving frame securely. Hence, the cover body can be prevented from shaking and wobbling.

4. It is arranged that the gap is formed in the region between the upper inclined surfaces of the cover body and receiving frame which meet each other and the lower inclined surfaces thereof which meet each other so that the

outer circumference of the cover body and the inner circumference of the receiving frame do not touch each other in this region. The area of contact between the inclined surface of cover body and the inclined surface of the receiving frame can be adjusted by this arrangement. This means that the force which wedges the cover body into the receiving frame can be controlled easily.

5. The intermediate inclined surface of the receiving frame includes the receiving-frame convex part projecting to the inside of the receiving frame, and the intermediate inclined surface of the cover body includes the cover-body convex part. Hence, when the cover is going to be closed, the cover-body convex part shifts, being guided by the receiving-frame convex part. Hence, the cover body can be smoothly fitted into the receiving frame only by dragging the cover body with a crowbar or pushing in the cover body from behind.